2000P11523

Foreign version

Method for interior-space/exterior-space detection of a response transmitter which communicates in wire-free fashion with a base station, and a communications system

The invention relates to a method for interior-space/exterior-space detection of a response transmitter which communicates in wire-free fashion with a base station, and a communications system.

Communications systems are known which have a base station which contains a transmitter/receiver unit, and a response transmitter which, with a signal containing an item of code information, transmits a response signal in response to an interrogation signal, which response signal is received by the base station and evaluated with respect to the code information in order to identify the response transmitter.

In such a system known from EP 0 153 613 B1, the response transmitter contains a strip of magnetostrictive, ferromagnetic material which resonates mechanically at a preselected frequency within a frequency band. This response-transmitter specific resonance is detected by the base station as code information, with the result that when the code information corresponds to a previously stored code information item an access system, for example, is enabled. The particular advantage for a user of such a communications system lies in the fact that merely carrying the response transmitter is sufficient to provide proof of the person's access authorization. In the keyless access system which is known from EP 0 153 613 B1 and which is used, for example, in a motor vehicle, a plurality of interrogation zones are defined by connecting a plurality of transmitter/receiver antennas to the base station, said antennas being arranged at predetermined points on the vehicle, for example in the vicinity of the driver's

door and front seat passenger's door and being used to emit short-range interrogation signals, to whose reception the response transmitter responds. It is also possible to arrange such an antenna within the trunk so that it is detected whether the response transmitter has been left in the trunk, and given a positive detection the trunk is, for example, automatically prevented from being locked. The known keyless access system contains additional proximity sensors so that it is activated to emit an interrogation signal only if a person approaches a proximity sensor, for example.

A desirable, additional functionality of such a communications system consists in the fact that it is possible to detect whether the response transmitter is located inside or outside a space, in which case the communication between base station and response transmitter will be maintained irrespective of the location of the response transmitter, provided that the response transmitter is located in the transmitter range of the base station. In this way, it is possible to carry out enabling measures or control measures which depend on the location of the response transmitter or of a person carrying the response transmitter, these being for example, special authorizations for carrying out safety-relevant functions, as soon as it is ensured that the response transmitter is located in an interior space.

The invention is based on the object of implementing, in a communications system with at least one base station and at least one response transmitter, the functionality of detecting whether the response transmitter is located inside or outside a space.

The method defined in claim 1 provides a means of achieving the abovementioned object.

An interior space in conjunction with which the method according to the invention can be applied is, for example, a space which is enclosed by electrical

conductors. Such a space can be a space within a building, for example a space which is critical for safety, or the interior of a motor vehicle, etc. Depending on the construction of the electrical conductors, electromagnetic waves above a predetermined frequency are allowed to pass through, essentially without attenuation, through the walls into the interior space. On the other hand, at large wavelengths or very low frequencies, the incoming waves or fields are not let through the walls owing to the influence of the electrical conductors. Communication between the base station and the response transmitter in a frequency range which is let through by the walls can thus be carried out irrespective of whether the base station and the response transmitter are located inside or outside the interior space. On the other hand, communication in a frequency range to which the walls are impermeable can take place only if the base station and the response transmitter are located on the same side of the walls of the interior space. By making expedient use of both frequency ranges for the communication it is thus possible for the response transmitter and the base station to communicate with one another continuously, but it is still possible to determine whether they are located on different sides of the walls of an interior space.

The subclaims 2 to 5 are concerned with advantageous ways of implementing the method according to the invention.

Claim 6 is concerned with the basic design of a communication system for achieving the object of the invention.

This communication system is advantageously developed with the features of claims 7 and 8.

According to claim 9, the communications system is suitable in particular for use within anti-theft system or access control system of a motor vehicle.

The invention is explained in more detail below by way of example and with reference to schematic drawings, in which:

Fig. 1 shows a block circuit diagram of a communications system according to the invention, and

Fig. 2 shows a flowchart explaining the method of operation of the communications system.

According to fig. 1, an interior space 2 is surrounded by walls 4 which are indicated by dashed lines and which contain electrical conductors 6, for example in the form of a lattice or in the form of flat components, as in the example of a motor vehicle.

In the example illustrated, a base station 8 is equipped, inside the interior space 2, with a transmitter/receiver unit 22 with a transmitter/receiver antenna 12 via which communication signals are transmitted and received. Furthermore, the base station 8 has a transmitter unit 14 for local interrogation signals, which transmitter unit 14 is connected to a transmitter antenna 16 located in the interior space 2, and a transmitter antenna 18 located in the exterior space.

The base station 8 contains further units (not illustrated) for generating the transmitted signals and for evaluating the received signals, as well as a control unit, preferably provided with a microprocessor, for controlling the operation.

The design and function of the individual elements or modules of the base unit are known per se and therefore not explained.

Furthermore, the system includes a response transmitter 20 with a transmitter/receiver unit 22 for communication signals, which transmitter/receiver unit

22 has a transmitter/receiver antenna 24, and a receiver unit 26 with a receiver antenna 28 for local interrogation signals.

In a way similar to the base station 8, the response transmitter 20 contains assemblies for generating these transmission/reception signals, for storing code information, for evaluating the received signals and for controlling the entire operation, and the design of said assemblies is known per se and is therefore not explained. The basic design of the response transmitter 20 can be similar, with the exception of the additionally provided receiver unit 26, to that of the data carrier, known per se, or response transmitter of keyless access control systems of motor vehicles.

For the walls 4 of the interior space 2 there is a critical wavelength λ_C which is dependent essentially on the distance between the electrical conductors 6 and above which electromagnetic waves do not penetrate the walls owing to the shielding effect of the electrical conductors 6. For the wavelengths λ_K which are used in communication signals, and for the wavelengths λ_O which are used for local interrogation signals, the following applies: $\lambda_K < \lambda_C < \lambda_O$. Accordingly, the operating range of a local interrogation signal or local detection signal is restricted to the region outside or inside the interior space 2 depending on whether the transmissions occur outside or inside the interior space, while the operating range of the communication signals covers the exterior and the interior space. The power with which the communication signals are transmitted, and the sensitivity of the associated receiving devices, are advantageously selected in such a way that the operating range is greater than the external dimensions of the interior space 2 and smaller than the operating range of a local interrogation signal. In fig. 1, a

communication signal 30 is represented throughout as a bidirectional signal. A local interrogation signal 32 is represented as a unidirectional signal by means of dashed lines.

In an extreme case, the frequency of a local interrogation signal may be virtually zero, i.e. a static electrical field can be excited.

The method of operation of the system described will be explained below with reference to an example of an interrogation strategy according to fig. 2.

It will be assumed that the base station 2 outputs a communications interrogation signal KAFS periodically or controlled as a function of events. If one of a plurality of possible response transmitters is located in the operating range of the base station 2 or inside its transmitting range, this response transmitter responds in step 42 with a communications response signal KATS which contains its identifier. This response signal KATS is received by the base station 8 in step 44 and the identifier is checked in step 46. Given a check with a positive result (step 48), the system knows that there is an authorized response transmitter located in its area.

In order to initiate a specific action, the system must know, inter alia, whether the response transmitter, or a response transmitter, is located inside or outside the interior space 2. For example, the vehicle is only allowed to be locked if a response transmitter is located outside the interior space, or the motor is only allowed to be started if a response transmitter is located inside the interior space etc. It will be assumed in the present example that in step 50 it is determined that a local detection is necessary because it has to be detected, for example for a locking operation, whether a response transmitter is located outside the interior space or the vehicle. The base station 2 then transmits, in step 52, a

communication signal AK with the content that a location interrogation signal is transmitted at a time t_1. The response transmitter activates, in step 54 at the time t_1, its receiver unit 26 for the reception of the local interrogation signal. At the time t_1, the base station 8 transmits the local interrogation signal OAFS via the antenna 18 located outside the interior space 2. After the time t_1, the response transmitter 20 informs the base station 8, in a communications response signal in step 60, whether or not it has received the local interrogation signal in step 58.

If the local interrogation signal OAFS has been received in step 58, it is possible to conclude that the response transmitter 2 is located outside the interior space 2 and the vehicle can be locked (steps 62, 64).

If no local interrogation signal was received, it may be expedient to make additional positive checks as to whether the response transmitter is located in the interior of the vehicle in order to make sure that the non-reception of the local interrogation signal is not due to an error in the response transmitter. To do this, steps 72 to 84 which are similar to steps 52 to 64 are run, with the single difference that the local interrogation signal OAFS is transmitted by the antenna 16 located within the interior space 2 at a time t_2. This time is transmitted to the response transmitter 20, as described above, by means of a communication signal in step 72. The response transmitter then switches its receiver unit 26 to the active state in step 74 at the time t_2. The response transmitter 20 subsequently informs the base station 8, in step 80, whether or not the response interrogation signal has been received.

If the response transmitter 20 has not received a local interrogation signal at the time t_1 and has received a local interrogation signal at the time t_2,

it is reliably determined that the response transmitter is located inside the interior 2 (step 84).

The time period between t_1 and t_2 is advantageously selected to be small in order to ensure that the position of the response transmitter has changed only slightly during the interrogations.

The system described above and the interrogation strategy can be modified in diverse ways.

The determination of the location advantageously takes place in such a way that the space is interrogated first, and the local interrogation signal is transmitted via that antenna which is assigned to that space in which the signal transmitter must be located for an action to be enabled.

Alternatively, the local interrogation signal can be generated by the response transmitter and evaluated in the base station which then has two reception antennas.

The base station and/or the response transmitter may be designed in such a way that in each case the reception of a local interrogation signal which is transmitted in the frequency range to which the walls are impermeable automatically triggers a response signal which is transmitted in the other frequency range. In this way, that part of the bidirectional communication which otherwise takes place exclusively in the frequency range to which the wall 4 is permeable and triggers an activity of a part (data carrier or base station) which receives a local interrogation signal, takes place by means of the local interrogation signal which is used unidirectionally.

In order to shorten the reaction time, the communication signals and the local interrogation signal can be generated simultaneously because they can be identified unambiguously owing to their different frequencies. Furthermore, the communication signals within a communications frequency channel can be

transmitted with a specific bandwidth. The same applies to the local interrogation signals.

If local interrogation signals with different features are used inside the interior space and outside the interior space, identical times can be selected for the times t_1 and t_2.

The antennas and the transmitter/receiver units for the different frequency ranges can be combined, insofar as is technically appropriate and expedient, within the base unit and the response transmitter.

The fact that the bidirectional communication takes place at the higher frequency meets the need to operate with a high Baud rate on the communications channel. On the other hand, by means of the lower-frequency local interrogation signal it is possible to operate with a high field strength so that the local interrogation signal can be used, for example, to activate or wake up the signal transmitter for a communication. It is also advantageous here that with the low-frequency interrogation signal the entire interior space is reliably covered and interrogated when an interior space interrogation occurs. Of course, the interrogation strategy or the bidirectional communication may be appropriately modified if the signal transmitter is only activated by a local interrogation signal.